

CLAIMS

1. An intermediate precursor composition for use in manufacturing a supported catalyst having a controlled coordination structure, comprising:

a plurality of catalyst atoms comprising at least one member selected from the group comprising noble metals, rare earth metals, transition metals, and non-metals; and

a control agent comprising a plurality of complexing molecules selected from the group comprising polymers, oligomers, and organic compounds, each control agent molecule having a plurality of functional groups disposed along a backbone for complexing the reactive catalyst atoms to the control agent molecules,

at least about 50% of the control agent molecules being straight-chained and at least a portion of the control agent molecules forming a catalyst complex between the catalyst atoms and the control agent molecules, the catalyst complex being capable of forming a supported reactive catalyst comprising a support and a plurality of reactive catalyst particles dispersed on the support in such a way that a preponderance of the catalyst atoms on an upper surface of the reactive catalyst particles have a nearest neighbor coordination number of 2.

2. An intermediate precursor composition as defined in claim 1, wherein at least a portion of the catalyst atoms comprise at least one noble metal selected from the group comprising palladium, platinum, iridium, gold, osmium, ruthenium, rhodium, and rhenium.

3. An intermediate precursor composition as defined in claim 1, wherein at least a portion of the catalyst atoms comprise at least one transition metal.

4. An intermediate precursor composition as defined in claim 3, wherein the transition metal comprises at least one member selected from the group comprising chromium, manganese, iron, cobalt, nickel, copper, zirconium, tin, zinc, tungsten, titanium, molybdenum, and vanadium.

5. An intermediate precursor composition as defined in claim 1, wherein at least a portion of the catalyst atoms comprise at least one rare earth metal.

6. An intermediate precursor composition as defined in claim 5, wherein the rare earth metal comprises at least one member selected from the group comprising lanthanum and cerium.

7. An intermediate precursor composition as defined in claim 1, wherein at least a portion of the catalyst atoms comprise at least one non-metal.

8. An intermediate precursor composition as defined in claim 1, further comprising at least one of an alkali metal or alkaline earth metal.

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9. An intermediate precursor composition as defined in claim 1, wherein at least a portion of the functional groups comprise a carbon atom bonded to at least one electron-rich atom that is more electronegative than the carbon atom and that is able to donate one or more electrons so as to form a bond or attraction with at least one of the catalyst atoms.

10. An intermediate precursor composition as defined in claim 9, wherein the electron-rich atom comprises at least one of oxygen or nitrogen.

11. An intermediate precursor composition as defined in claim 9, wherein the electron-rich atom has a negative charge and the catalyst atoms have a positive charge.

12. An intermediate precursor composition as defined in claim 1, wherein at least about 60% of the control agent molecules are straight-chained.

13. An intermediate precursor composition as defined in claim 1, wherein at least about 75% of the control agent molecules are straight-chained.

14. An intermediate precursor composition as defined in claim 1, wherein at least about 90% of the control agent molecules are straight-chained.

15. An intermediate precursor composition as defined in claim 1, wherein at least about 95% of the control agent molecules are straight-chained.

16. An intermediate precursor composition as defined in claim 1, wherein about 100% of the control agent molecules are straight-chained.

17. An intermediate precursor composition as defined in claim 1, further comprising a solvent or carrier into which the catalyst complex and any remaining catalyst atoms and control agent are mixed.

18. An intermediate precursor composition as defined in claim 17, wherein the solvent or carrier comprises water.

19. An intermediate precursor composition as defined in claim 17, wherein the solvent or carrier comprises at least one aqueous acid.

20. An intermediate precursor composition as defined in claim 17, wherein the solvent or carrier comprises at least one organic solvent.

21. An intermediate precursor composition as defined in claim 17, further comprising at least one support material.

22. An intermediate precursor composition as defined in claim 21, wherein the catalyst complex is impregnated within, but not chemically bonded to, the support material.

23. An intermediate precursor composition as defined in claim 21, wherein the catalyst complex is chemically bonded to the support material.

24. An intermediate precursor composition as defined in claim 1, further comprising at least one support material to which the catalyst complex is chemically bonded.

25. An intermediate precursor composition as defined in claim 1, wherein the control agent has a number average molecular weight in a range of about 300 to about 15,000 Daltons.

26. An intermediate precursor composition as defined in claim 1, wherein the control agent has a number average molecular weight in a range of about 600 to about 6,000 Daltons.

27. An intermediate precursor composition as defined in claim 1, wherein a substantial portion of the control agent includes from about 4 to about 200 functional groups per control agent molecule.

28. An intermediate precursor composition as defined in claim 1, wherein a substantial portion of the control agent includes from about 8 to about 80 functional groups per control agent molecule.

29. An intermediate precursor composition as defined in claim 1, wherein a substantial portion of the control agent includes from about 10 to about 20 functional groups per control agent molecule

30. An intermediate precursor composition as defined in claim 1, wherein the intermediate precursor composition includes a molar ratio of control agent functional groups to catalyst atoms in a range of about 0.5:1 to about 40:1.

31. An intermediate precursor composition as defined in claim 1, wherein the intermediate precursor composition includes a molar ratio of control agent functional groups to catalyst atoms in a range of about 1:1 to about 35:1.

32. An intermediate precursor composition as defined in claim 1, wherein the intermediate precursor composition includes a molar ratio of control agent functional groups to catalyst atoms in a range of about 3:1 to about 30:1.

33. An intermediate precursor composition as defined in claim 1, wherein the control agent comprises at least one of polacrylic acid or a polyacrylic acid salt.

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34. An intermediate precursor composition as defined in claim 1, wherein the control agent comprises at least one member selected from the group comprising polyvinylbenzoates, polyvinyl sulfate, polyvinyl sulfonates including sulfonated styrene, polybisphenol carbonates, polybenzimidizoles, polypyridine, sulfonated polyethylene terephthalate, polyvinyl alcohol, polyethylene glycol, and polypropylene glycol.

35. An intermediate precursor composition as defined in claim 1, wherein the catalyst complex comprises a random distribution of at least two different types of catalyst atoms.

36. An intermediate precursor composition as defined in claim 35, wherein the catalyst complex is capable of forming the supported reactive catalyst in a manner so that the catalyst particles also include a random distribution of at least two different types of catalyst atoms.

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37. An intermediate precursor composition for use in manufacturing a supported catalyst having a controlled coordination structure, comprising:

a plurality of catalyst atoms comprising at least one member selected from the group comprising rare earth metals, transition metals, and non-metals; and

a control agent comprising a plurality of complexing molecules selected from the group comprising polymers, oligomers, and organic compounds, each control agent molecule having a plurality of functional groups disposed along a backbone for complexing the reactive catalyst atoms to the control agent molecules,

at least about 50% of the control agent molecules being straight-chained and at least a portion of the control agent molecules forming a catalyst complex between the catalyst atoms and the control agent molecules, the catalyst complex being capable of forming a supported reactive catalyst comprising a support and a plurality of reactive catalyst particles dispersed on the support in such a way that a preponderance of the catalyst atoms on an upper surface of the reactive catalyst particles have a nearest neighbor coordination number of 2.

38. An intermediate precursor composition as defined in claim 37, wherein at least about 75% of the control agent molecules are straight-chained.

39. An intermediate precursor composition as defined in claim 37, wherein at least about 90% of the control agent molecules are straight-chained.

40. An intermediate precursor composition as defined in claim 37, further comprising a solvent or carrier into which the catalyst complex and any remaining catalyst atoms and control agent are dissolved or dispersed.

41. An intermediate precursor composition as defined in claim 40, further comprising at least one support material.

42. An intermediate precursor composition as defined in claim 41, wherein the catalyst complex is impregnated within, but not chemically bonded to, the support material.

43. An intermediate precursor composition as defined in claim 41, wherein the catalyst complex is chemically bonded to the support material.

44. An intermediate precursor composition as defined in claim 37, further comprising at least one support material to which the catalyst complex is chemically bonded.

45. An intermediate precursor composition as defined in claim 37, wherein the control agent comprises at least one of polacrylic acid or a polyacrylic acid salt.

46. An intermediate precursor composition as defined in claim 37, wherein the control agent comprises at least one member selected from the group comprising polyvinylbenzoates, polyvinyl sulfate, polyvinyl sulfonates including sulfonated styrene, polybisphenol carbonates, polybenzimidizoles, polypyridine, sulfonated polyethylene terephthalate, polyvinyl alcohol, polyethylene glycol, and polypropylene glycol.

47. An intermediate precursor composition as defined in claim 37, wherein the catalyst complex comprises a random distribution of at least two different types of catalyst atoms.

48. An intermediate precursor composition as defined in claim 47, wherein the catalyst complex is capable of forming the supported reactive catalyst in a manner so that the catalyst particles also include a random distribution of at least two different types of catalyst atoms.

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49. A method of preparing an intermediate precursor composition for use in manufacturing a supported catalyst having a controlled coordination structure, the method comprising:

providing a plurality of catalyst atoms comprising at least member selected from the group comprising noble metals, rare earth metals, transition metals, and non-metals;

providing a control agent comprising a plurality of complexing molecules selected from the group comprising polymers, oligomers, and organic compounds, each control agent molecule having a plurality of functional groups disposed along a backbone for complexing the reactive catalyst atoms to the control agent molecules, wherein at least about 50% of the control agent molecules are straight-chained;

mixing together the catalyst atoms and control agent in a liquid to form a mixture; and

reacting at least a portion of the catalyst atoms with at least a portion of the control agent to yield a catalyst complex that is capable of forming a supported reactive catalyst comprising a support and a plurality of reactive catalyst particles dispersed on the support in such a way that a preponderance of the catalyst atoms on an upper surface of the reactive catalyst particles have a nearest neighbor coordination number of 2.

50. A method of preparing an intermediate precursor composition as defined in claim 49, further comprising contacting the catalyst complex with a support.

51. A method of preparing an intermediate precursor composition as defined in claim 50, wherein the catalyst complex is impregnated within, but not bonded to, the support.

52. A method of preparing an intermediate precursor composition as defined in claim 50, further comprising reacting the catalyst complex with the support so that a portion of the control agent chemically bonds the catalyst complex to the support.

53. A method of preparing an intermediate precursor composition as defined in claim 52, wherein the portion of the control agent that bonds the catalyst complex to the support does so by means of a condensation reaction.

54. A method of preparing an intermediate precursor composition as defined in claim 52, wherein the portion of the control agent that bonds the catalyst complex to the support comprises an anchoring agent.

55. A method of preparing an intermediate precursor composition as defined in claim 52, further comprising removing the liquid so as to yield a supported catalyst precursor composition comprising the catalyst complex bonded to the support.

56. A method of preparing an intermediate precursor composition as defined in claim 49, wherein the catalyst complex includes a random distribution of at least type different types of catalyst atoms.

57. A method of preparing an intermediate precursor composition for use in manufacturing a supported catalyst having a controlled coordination structure, the method comprising:

providing a plurality of catalyst atoms comprising at least member selected from the group comprising rare earth metals, transition metals, and non-metals;

providing a control agent comprising a plurality of complexing molecules selected from the group comprising polymers, oligomers, and organic compounds, each control agent molecule having a plurality of functional groups disposed along a backbone for complexing the reactive catalyst atoms to the control agent molecules, wherein at least about 50% of the control agent molecules are straight-chained;

mixing together the catalyst atoms and control agent in a liquid to form a mixture; and

reacting at least a portion of the catalyst atoms with at least a portion of the control agent to yield a catalyst complex that is capable of forming a supported reactive catalyst comprising a support and a plurality of reactive catalyst particles dispersed on the support in such a way that a preponderance of the catalyst atoms on an upper surface of the reactive catalyst particles have a nearest neighbor coordination number of 2.

58. A method of preparing an intermediate precursor composition as defined in claim 57, further comprising contacting the catalyst complex with a support.

59. A method of preparing an intermediate precursor composition as defined in claim 58, wherein the catalyst complex is impregnated within, but not bonded to, the support.

60. A method of preparing an intermediate precursor composition as defined in claim 58, further comprising reacting the catalyst complex with the support so that a portion of the control agent chemically bonds the catalyst complex to the support.

61. A method of preparing an intermediate precursor composition as defined in claim 60, wherein the portion of the control agent that bonds the catalyst complex to the support does so by means of a condensation reaction.

62. A method of preparing an intermediate precursor composition as defined in claim 60, wherein the portion of the control agent that bonds the catalyst complex to the support comprises an anchoring agent.

63. A method of preparing an intermediate precursor composition as defined in claim 60, further comprising removing the liquid so as to yield a supported catalyst precursor composition comprising the catalyst complex bonded to the support.

64. A method of preparing an intermediate precursor composition as defined in claim 57, wherein the catalyst complex includes a random distribution of at least type different types of catalyst atoms.